

Evaluation of Stress-Strain Index (SSI) in Healthy and Keratoconic Corneas

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1. Purpose

To evaluate the performance of a new Corvis ST parameter denoted the Stress-Strain Index (SSI) as an in-vivo measure of material stiffness of healthy and keratoconic corneas.

2. Methods

A large parametric study was conducted on realistic ocular models simulating the air pressure of the Corvis ST (OCULUS; Germany), and input and output parameters were recorded and used to develop an algorithm for SSI. The study involved variations in the central corneal thickness (CCT), the intraocular pressure (IOP), age and other geometric parameters. The algorithm was validated using data obtained by Vincieye Clinic (Milan, Italy) for 414 healthy participants, 79 forme-fruste keratoconus (FFKC) subjects and 222 patients with confirmed keratoconus. The results were statistically analysed. Topography data obtained using a Pentacam (OCULUS) were analysed using Topographic Keratoconus Classification (TKC) (Chen, JCRS, 2019) to categorise the eyes into different KC stages. IRB approval in the form of written and informed consent was obtained to use the data in scientific research in accordance to the tenets of the Helsinki Declaration revised in 2013.

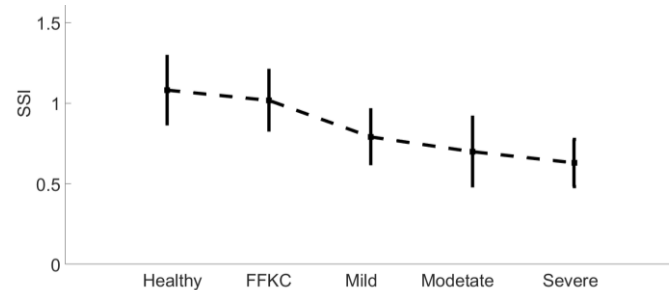


Figure 1, The mean and standard deviation of among Healthy, FFKC, Mild, Moderate and Severe KC cases.

3. Results

The mean SSI was 1.08 ± 0.21 , 1.02 ± 0.18 , 0.79 ± 0.17 , 0.70 ± 0.21 and 0.63 ± 0.15 in healthy participants and patients with FFKC, mild, moderate and advanced KC, respectively, showing gradual, consistent and significant decreases with keratoconus progression ($p < 0.05$), Figure 1. As expected, the correlation between SSI and CCT was not significant in both the healthy population ($p = 0.552$) and the KC population ($p = 0.205$), while the correlation with age was significant in healthy eyes ($p < 0.05$). The correlation with age in KC eyes was not significant ($p = 0.141$) possibly due to the biomechanical changes in the tissue caused by the disease, Figure 2.

4. Conclusion

The results revealed consistent reductions in SSI with keratoconus progression and independence of corneal thickness. This parameter may be used for personalised medicine to optimise procedures such as corneal cross-linking.

Financial Disclosure

European Project Imcustomeye H2020-ICT-2017 Ref. 779960

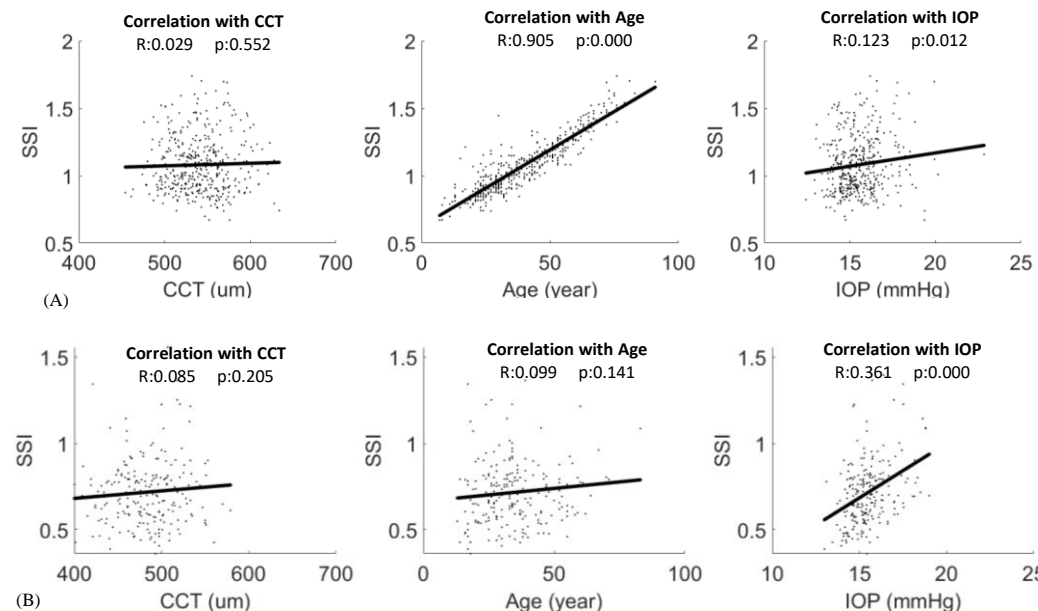


Figure 2, Comparison between SSI in terms of correlations with CCT, Age and IOP in (A) healthy and (B) KC groups